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Shelters

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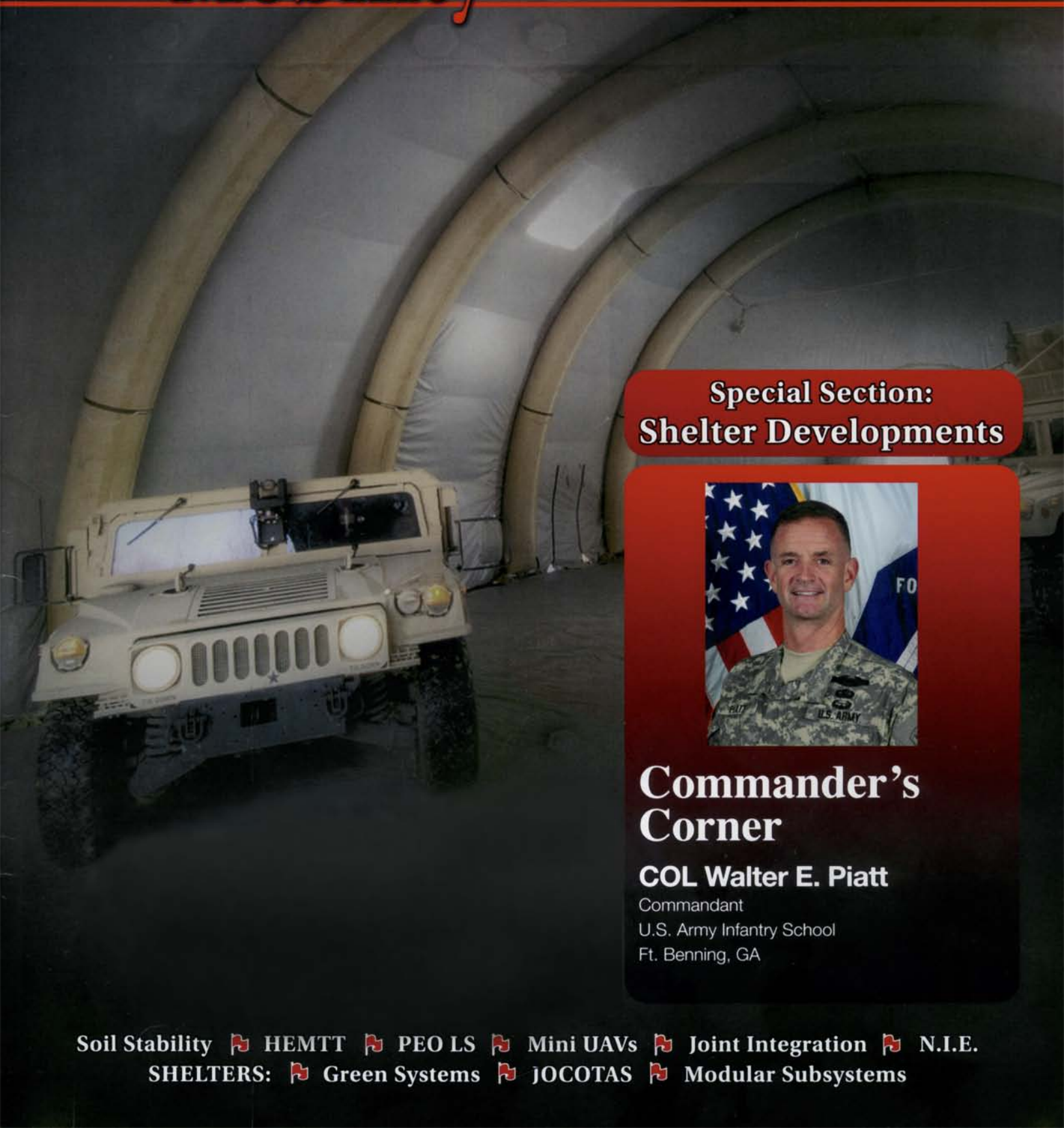

Special Section: Shelter Developments

Commander's Corner

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Soil Stability ⚑ HEMTT ⚑ PEO LS ⚑ Mini UAVs ⚑ Joint Integration ⚑ N.I.E.
SHELTERS: ⚑ Green Systems ⚑ JOCOTAS ⚑ Modular Subsystems

Report Documentation Page

Form Approved
OMB No. 0704-0188

1. REPORT DATE	2. REPORT TYPE	3. DATES COVERED
SEP 2011		**00-00-2011 to 00-00-2011**

4. TITLE AND SUBTITLE	5a. CONTRACT NUMBER
Armor & Mobility	5b. GRANT NUMBER
	5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)	5d. PROJECT NUMBER
	5e. TASK NUMBER
	5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **U.S. Army Natick Soldier RDEC,Director, Shelter Technology, Engineering & Fabrication,Natick,MA,01760**	8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)	10. SPONSOR/MONITOR'S ACRONYM(S)
	11. SPONSOR/MONITOR'S REPORT NUMBER(S)

12. DISTRIBUTION/AVAILABILITY STATEMENT
Approved for public release; distribution unlimited

13. SUPPLEMENTARY NOTES
Published in Armor and Mobility, Sept. 2011, 1/20

14. ABSTRACT

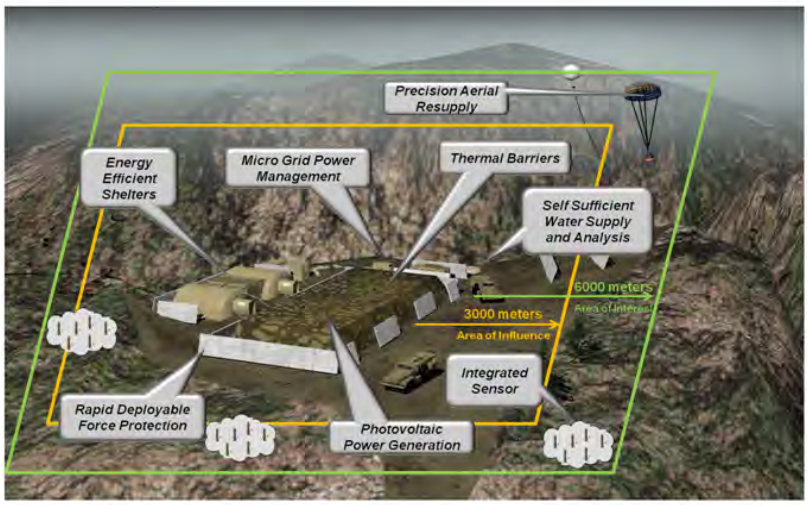
15. SUBJECT TERMS

16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES	19a. NAME OF RESPONSIBLE PERSON
a. REPORT	b. ABSTRACT	c. THIS PAGE			
unclassified	**unclassified**	**unclassified**	**Same as Report (SAR)**	**9**	

Military Forges Path Forward to Reduce Contingency Basing Energy Requirements
The JOCOTAS is a DoD-sponsored organization that enables and promotes cross-service communication within the shelter technology and engineering development communities.
By Frank E. Kostka

Operational energy is a critical element for military force projection. This is particularly true for contingency basing operations that emanate from austere environments and are supported by extended supply lines through hostile terrain. Contingency bases are the lethality projection platform in asymmetrical warfare. Energy self-sufficiency reduces causalities and resources associated with convoy protection, cuts fuel related expenses and increases the number of warfighters available for combat operations. The military has several recently completed programs to reduce power demand and develop alternative sources. These include the Office of the Secretary of Defense's (OSD) Joint Net Zero Plus (NZ+) Joint Combined Technology Demonstration (JCTD) at the National Training Center (NTC), Fort Irwin, California and the Marine Corps Ex FOB program at Marine Corps Air Ground Combat Center (MCAGCC) 29 Palms, California.

The need for an overarching approach to energy management was articulated in the May 2011 Department of Defense (DoD) Energy for the Warfighter: Operational Energy Strategy; codified in the draft Army Campaign Plan (June 2011); and implemented through a recent action memo from General James N. Mattis, Commander, U.S. Central Command, dated July 12, 2011. The CENTCOM commander's July memo stated in part, "Operational Energy Requirements for U.S. Forces in Afghanistan: To better manage base camp energy demands, U.S. Forces-Afghanistan has identified requirements that include energy efficient generators, power distribution systems, shelters, and a capability to measure energy usage for more effective energy management. Opportunities exist to improve power generation and electrical distribution systems."



The US military and our industry partners are developing, testing and evaluating, self sustaining contingency basing capabilities that expedite and enhance force protection while decreasing Small Unit Squad manpower requirements. The goal is to increase mission effectiveness. New thermal barriers integrated with photovoltaics conceal forces from prying eyes, block solar loading, passively cool shelters and, produce power. Microgrids manage sources of power to optimize efficiencies and distribution. Water supplies are recycled where possible and augmented by atmospheric extraction. Sensors interlink Small Unit Squads with wide area command and control networks and, supportingfires.

Future Combat Outpost (COP) Concept. Credit: Steve Smith, NSRDEC Strategic Communications

Operational energy is viewed in the context of warfighter activities and mission priorities on both a tactical and strategic perspective. The services have broad responsibilities in contingency

environments to shelter warfighters against an array of threats to include severe weather, chemical and biological warfare agents, ballistic threats and electronic surveillance. If the military is unable to mitigate a threat and accomplish the mission, it employs a systemic process to identify and solve capability gaps associated with DOTMLPF (Doctrine, Organization, Training, Materiel, Leadership and Education, Personnel, and Facilities). The Functional Solutions Analysis is the last step in this Capabilities Based Assessment process and it identifies materiel and non-materiel solutions to fill identified capability gaps. In simple terms this means we change the way we execute a mission or we develop a new piece of cutting edge equipment. The former is more expeditious and less costly. The new equipment solution or, materiel approach assesses commercial off- the-shelf items, existing military hardware employed by other services and maturing technologies. The Joint Committee on Tactical Shelters (JOCOTAS) is a DoD-sponsored organization that is an enabler in this activity because it promotes cross-service communication within the shelter technology and engineering development communities. JOCOTAS over the past two years has focused on contingency basing or base camps in an effort to reduce deployment time, enhance expeditionary force protection and evolve basing into a self sustaining capability.

DoD leadership recognized early-on that energy use in both fixed facilities and contingency bases was a major challenge both in terms of warfighter causalities and expenditures. In 2004 the Rapid Equipping Force (REF) sought solutions to reduce harsh conditions on warfighters and cut energy demand. Solar covers produced during the first Gulf War (Operation Desert Storm) and then stored in War Reserve stocks were quickly depleted. A follow-on Advanced Solar Cover (ASC) program completed development and was the basis for contract awards and fielding of approximately 14,000 units during 2004-2009. In 2006 the Power Surety Task Force was established to address renewable energy issues identified in a Joint Urgent Operational Needs Statement originated by the Marine Corps. The REF initiated a series of worldwide experiments including applying spray polyurethane foam to structures and expeditionary shelters.

Spray Polyurethane Foam Experiment

The use of polyurethane foam sprayed on expeditionary shelters was initially viewed as an innovative solution that would save Warfighter lives related to convoy protection casualties while significantly reducing fuel needs. It became controversial in 2008 when a contracting officer in Kuwait raised safety concerns and sought support from PM Force Sustainment Systems (PM FSS) and U.S. Army Natick Soldier Research, Development and Engineering Center (NSRDEC) on preparations for a spray foam contract. Both NSRDEC and PM FSS began an in-depth assessment of design criteria and strongly recommended a requirement of at least two exits for each shelter. JOCOTAS also held extensive discussions on the pros and cons of foaming and the consensus was that shelter subject matter experts were never consulted and the program needed to be monitored for lessons learned.

In 2009 the Army's fire and safety experts raised concerns about the safety and use of the foam. The Air Force presented similar concerns and also addressed the reduced air quality inside

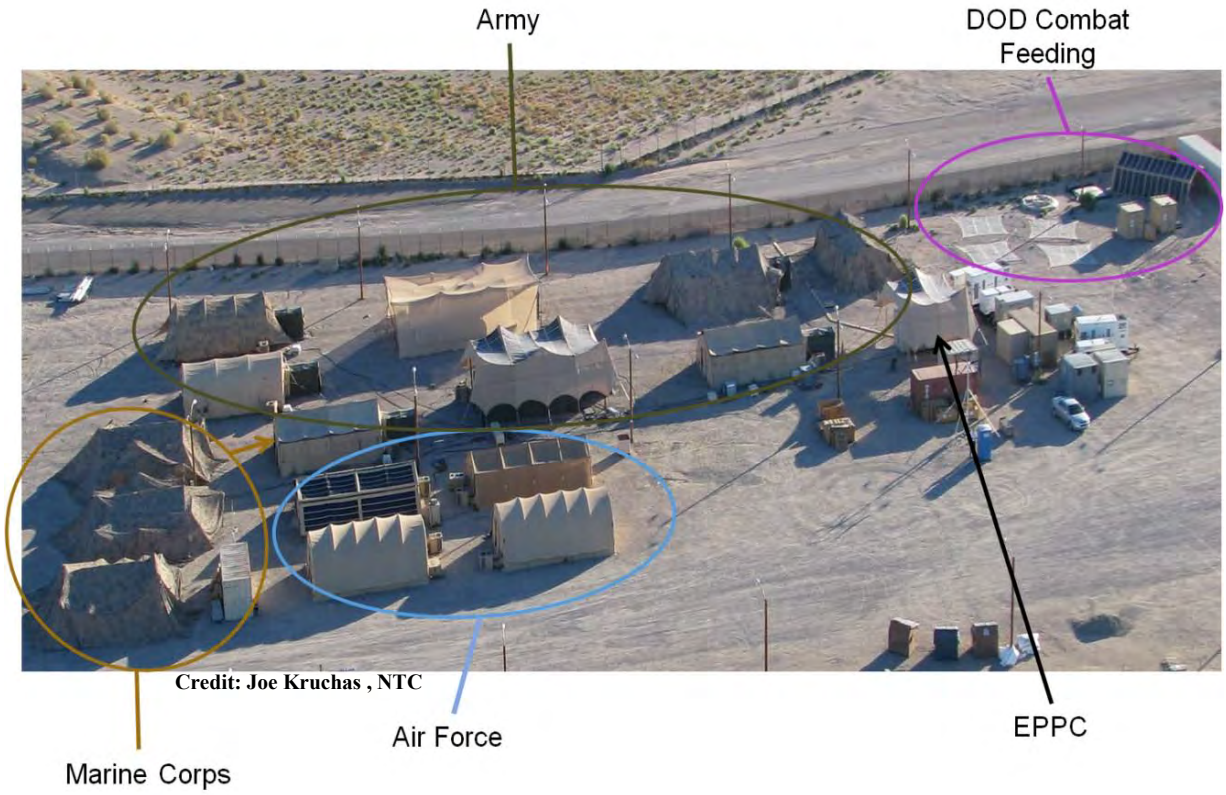
foamed shelters, health hazards of the uncured foam components and appropriate disposal. Amy Soo Klopotoski, the NSRDEC S&T lead for contingency basing, guided an assessment team and participated in fire testing on shelters with and without foam. She reported, "When NFPA testing was conducted on the tent without foam, the shelter fabric melted away where it was in contact with flames, then self-extinguished, allowing heat and smoke to escape. When conducted on the tent with foam, the foam contained so much of the heat that temperatures inside the tent jumped to dangerous levels and the smoke layer descended within one minute. In addition, temperatures rose so quickly that burning material was falling from the ceiling within 30 seconds. At one minute flashover occurred where the flames blow out the doorway." The conclusion of these tests was that the foam presents an increased fire risk. In October 2009 a Safety of Use Message was issued to alert commanders of the hazards of foam, and to provide guidance to mitigate those hazards.

NSRDEC is developing high performance solar barriers and thermal insulation, which provide the energy management performance of the foam without the drawbacks. Concepts such as cellular insulation leverage the thermal resistance of strategically designed air pockets, yet packs in a compact size for easy transport. Advanced materials such as synthetic fibers with various densities or phase change materials are also under investigation. The latest in Advanced Phase Change Integrated Composite (APChIC) materials provide a passive method of absorbing and releasing ambient thermal energy for environmental control. Unlike earlier phase change materials APChICs replace fluid modules with capillary structures that reduce bulk and potential leaks. Initial test results indicate the power demand to heat and cool a shelter can be significantly reduced using composite insulation incorporating phase change material. NSRDEC is dedicated to working with PM FSS and JOCOTAS partners to leverage these technologies and validate a design suitable for the needs of the military

Other Energy Management Efforts

Results also began to emerge on a wide array of other energy management efforts for expeditionary shelter and alternative energy production. OSD's Net Zero Plus (NZ+) Program was a key joint service effort. In December 2007 OSD's NZ+ JCTD was approved to begin at the National Training Center and the program was transitioned to the OSD Energy Security Task Force under the leadership of Barbara Brygider.

In May of 2008 General Benjamin S. Griffin, the Commanding General, U.S. Army Materiel Command, tasked the Research, Development and Engineering Command's (RDECOM) NSRDEC to support the program. Working in concert with PM FSS, NSRDEC created a plan to evaluate emerging expeditionary shelter energy management technologies. JOCOTAS invited other services to participate and the Army, Air Force and Marine Corps assessed fourteen shelters configurations, high performance insulation, photovoltaic arrays, LED lighting and microgrid technologies. The DoD Combat Feeding program evaluated prototype photovoltaic refrigeration units and PM FSS, besides supporting the shelter evaluation, also demonstrated a waste-to-energy conversion unit.



Logistics Support Area Warrior Net Zero Test Site at NTC

Brygider summarized the NZ+ JCTD program. "The objective of the NZ+ JCTD was to reduce fuel consumption at Forward Operating Bases (FOB). By reducing energy demand, providing efficient power distribution, and utilizing alternative energy, fuel consumption was minimized. NZ+ demonstrated energy efficient structures, energy efficient lighting, intelligent power distribution and renewable energy technologies. The NZ+ JCTD began in FY 2008 after the Joint Requirements Oversight Council (JROC) validated the capability for Army sponsorship. The NZ+ demonstration site was the National Training Center at Fort Irwin, California, expanded across several FOBs to allow for concurrent data recording of difference technologies. The initial focus for FYs 2008 and 2009 was demand reduction with installation of energy efficient structures. Demand was further reduced with power management and microgrid technologies in FY2010. Solar power was added to the microgrid in early 2011. NZ+ JCTD was a three and a half year demonstration under the sponsorship of U.S. CENTCOM and was completed in March 2011. The Military Utility Assessment is scheduled for completion by summer 2011. Technologies such as solar shades will transition to programs of records. Other technologies, such as the microgrid, were deployed to the operational theater,"

Brant Lagoon, a physical scientist, and Laura Biszko, a civil engineer, from NSRDEC managed much of the expeditionary soft shelter technology testing. Biszko recalled, "Noel Pleta from PM MEP instrumented our 18 month Joint Net Zero study at the National Training Center and captured on separate recorders, data on power draw of HVAC units and convenience outlets within billeting type tents. Real time data was collected on the energy required to environmentally control the shelters, to power advanced lighting systems, and determine electrical loads inside the shelters. The data was then analyzed in order to find the combinations

of shading, insulation and lighting technologies that provide the greatest reductions in energy demand in comparison to the baseline system. Findings from the demonstration indicate that a combination of shades and insulation can greatly reduce the power demand of the environmental control unit, which could lower fuel consumption. In addition, implementing these technologies will not increase the contingency basing footprint or negatively impact mission effectiveness.

Data analysis also revealed several interesting facts:

[1] Temperatures at NTC are similar to Baghdad and about 10 degrees (F) warmer than Kandahar;
[2] Convenience outlets may play a major role in power draw depending on the maturity and occupancy longevity of the base camp (how long has a unit been at the base camp and how much plug-in equipment have they bought from the Army & Air Force Exchange Service (AAFES));
[3] Confirming reports from Afghanistan HVAC units did not operate at full capacity year round. Over the spring, summer and fall cooling season (274 days) no AC is required about 35 percent of the time (during the night time hours);
[4] Simple solutions like solar barriers (solar covers and ULCANS camouflage nets) can easily reduce cooling requirements by 30-40 percent; and
[5] During the heating season insulated liners can provide similar results.

Credit: Laura Biszko **Credit: Frank Kostka**

NZ+ Testing of Army Polyimide Substrate and Air Force Stainless Steel Substrate Photovoltaic Arrays

JOCOTAS provides a platform for the services to collaborate and share technical information. The services have teamed on several technology development initiatives over the years, to include partnering on joint projects or leveraging and transferring technologies. The development of flexible photovoltaic (PV) systems for military applications is one collaborative success.

The Army pioneered flexible PV arrays that convert energy from the sun into electrical power. The power generated is direct current (D/C)-based and can be converted to alternating current power or stored as D/C in batteries. Versions of the PV integrated shelter products have been transitioned to both the U.S. Marine Corps and Air Force and tailored for their applications. The Air Force also experimented with a stainless steel-based product at NZ+ which is more efficient but less flexible. The diameter of a rolled stainless steel panel is approximately 30 inches. Steve Tucker, NSRDEC's PV expert, explained why the more flexible version, which can be folded like a blanket, is better for contingency basing applications. **"**PV integrated shelter products utilize amorphous silicon (a-Si) technology on polyimide (i.e. plastic) substrate. The benefits of this combination are a lighter weight product than similar a-Si PV on stainless steel, and lower

cost of the PV resulting from on-going improvements such as roll to roll processing, and multi-beam laser etching of the film during manufacture." The Army evaluated this technology in multiple configurations including a standalone 1 KW solar array at NZ+, where data indicated that energy production was approximately 8 percent efficient. This is low compared to rigid PV panels but has the advantage of being able to be applied directly to tents or solar shades. This integration into existing structures reduces the required PV footprint, a concern where base camp site space is at a premium. Also it can be tightly folded into tight shipping configurations, critical for military logistics. Users have expressed some concerns about the reflectance of the covers providing targeting information to hostile forces. This issue is being assessed by NSRDEC.

As data from the Net Zero + JCTD is analyzed by NSRDEC, lessons learned emerge from the Marine Corps ExFOB test bed and promising technologies mature, the services will continue to seek out new capabilities to that reduce the military's need for energy.

LED Lighting is one area where immediate action is being taken. Results from NTC documented minimal energy savings. Since NetZero closed out in March 20011 a new generation of lights has emerged that industry data demonstrates a 45% reduction in power draw. These lights have a dimming capability that further reduces power draw to a 14 watt total demand per fixture. They also have the ability to convert to tactical blue mode without the use of add on filters. The Marine Corps has delivered 410 of these LED units to Camp Leatherneck in Afghanistan. NSRDEC recently initiated a program to establish an illumination test facility that will enable concurrent evaluation of 6 types of lighting inside of a standard 32' Force Provider shelter. The shelter will be fully instrumented to measure light levels.

Credit: David Kamm, NSRDEC Strategic Communications *Credit: PM FSS*

From left to right) Kevin Fahey, PEO CS/CSS, shares the Force Provider Systems Integration Laboratory, Fort Devens, ribbon cutting honors with Katherine Hammack, ASA Installations Energy and Environment, Sharon Burke ASD Operational Energy Plans and LTC Warren Bacote, Fort Devens, Garrison Commander

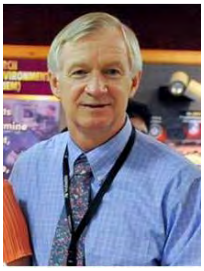
The department's commitment to energy self-sufficiency was further enhanced when, on June 21, 2011, the Army opened a Base Camp System Integration Lab (SIL) at Fort Devens, Massachusetts to evaluate future technologies in a live soldier environment and compare results

against a standard Force Provider 150 Soldier package. This is a complete system that provides, shelters, hygiene complexes, field feeding, laundries and recreational components. It comes complete with its own water distribution system, grey and black water management capability and power generation and electrical grid. One of the first areas that is being assessed is a simple microgrid developed by PM MEP. The system links six, 60 kW Tactical Quiet Generators (TQG) together in parallel acting as an energy pool similar to commercial power. TQGs can be activated as required ranging from 60 kW to 360 kW depending on the demand.

NSRDEC recently signed an MOU with PM FSS to work in concert to evaluate emerging technologies at the SIL. This was strongly supported Mr Kevin Fahey, PEO CS/CSS, Ms. Katherine Hammack, ASA Installations Energy and Environment and Ms. Sharon Burke ASD Operational Energy Plans who recently met with Dr Jack Obusek, NSRDEC's Technical Director, during the SIL's VIP day.

The other services also continue to pursue energy solutions. Rod Fisher, from the Air Force Civil Engineering Support Agency, commented on his service's latest developments. "We moved our testing from Fort Irwin to Holloman AFB, NM. We will be testing there through this year, additional liners, fly materials, and ECUs. Our goal is to cool two shelters with one ECU, identify a more efficient ECU for BEAR (basic expeditionary airfield resources) and continue to evaluate PV. We will be installing a tracker to conduct side-by-side evaluation of up to 3 PV technologies which we will then be able to compare to our test baseline. At the end of the testing, we will develop requirements for an energy efficient BEAR shelter system, and vet this with the Army through the JEBWG (Joint Expeditionary Basing Working Group) for potential joint fielding. OSD continues in a leadership role. Ms. Burke's Operational Energy Planning Office recently deployed a team to Afghanistan with an RDECOM science advisor in an effort to implement a range of energy-related technologies identified by the services' recently completed assessment programs. The team, supported by NSRDEC and PM FSS, will evaluate current operations, capture relevant data and soldier feedback, rapidly analyze the results and deliver recommendations to senior leadership for action. The Marine Corps is also hosting ExFOB Phase V program at MCAGCC 29 Palms as well as continuing an ongoing program the field the best energy management technologies and systems to troops in Afghanistan.

Editor's note: Frank Kostka is the Director, Shelter Technology, Engineering & Fabrication, U.S. Army Natick Soldier RDEC and the Executive Secretary of JOCOTAS. He may be contacted at frank.kostka@us.army.mil



Credit: David Kamm.

Frank Kostka is the Director of Shelter Technology and Engineering at the US Army Natick Soldier RDEC. He is the Executive Secretary of JOCOTAS and has 30 years experience in Contingency Basing.